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Stability Analysis of High Yielding Varieties of Black Gram (*Vigna Mungo* L. Hepper)

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Abstract

Most of the varieties show great degree of genotype x environment interactions for highlydesirable characters. Field experiment was conducted using fourteen genotypes of black gram during kharif season, 2009 and 2010. The data were analyzed according to the stability model as suggested by Eberhart and Russell (1966). The pooled analysis of variance due to genotypes was found highly significant for all the characters indicating genetic variability among the genotypes. Highly significant pooled deviation for all the characters except 100 seed weight was observed in all the genotypes that fluctuated significantly from their respective linear path of response to environments.From the estimated parameters of stability in the present study, genotypes RBU1012 and Pant U-19 were considered to be the most stable genotypes. Environments 6 was the best for yield and its components while environment 1 was the lowest for yield and its components.

Highlights

- 14 genotypes of black gram were selected for the study of stability analysis of high yielding varieties of black gram.
- Genetic variability among the genotypes was indicated by the pooled analysis of variance due to genotypes.
- Most stable genotypes were RBU1012 and Pant U-19, environment 6 was best for yield and its components and environment 1, the lowest.

Keywords: Black gram, stability, seed yield, component characters

Black gram (*Vigna mungo*), which belongs to leguminaceae family is a very important pulse crop in India. Black grain is grown throughout India. It is commonly used in the form of fermented food such as idli, dosa,papad, and other regional foods in India. It is consumed in the form of split pulse as well as whole grain, which is a good source of protein and an essential supplement of cereal based diet. It is also ground into flour and used to make cakes, pori, and porridge. Besides, it is used as a nutritive fodder especially for milch cattle.

India is the world's largest producer as well as consumer of black gram. It produces about 1.5 to 1.9 million tons of black gram annually from about 3.5 million hectares of area, with an average productivity of 500kg per hectare. There is a distinct change in production pattern of black gram across states. As per the latest available estimates, UP and Andhra Pradesh occupy the first two positions, contributing over 40%. Maharashtra contributes about 14% while Tamil Nadu and Madhya Pradesh account for about 10% and t 8.5% respectively of total production in the country (Source: (MOA, GoI). In north eastern hill states of India black gram is not commonly cultivated except in few states like Assam, Manipur and very few in Nagaland and Arunachal Pradesh.

It contains about 24% protein, 60% carbohydrates, 1.3% fat, and is the richest among the various pulse in phosphoric acid, being 5 to 10 times richer than in others (Modern Techniques of raising field crop, by Singh). In addition, being an important source of human food and animal feed**,** it also plays an important role in sustaining soil fertility by improving soil physical properties and fixing atmospheric nitrogen. Being a drought resistant crop, it is suitable for dry land farming and predominantly used as an intercrop with other crops.

Most of improved varieties performed in consistent performance under varied environmental conditions due to genotype environment interaction. Stable genotypes of black gram are necessary to increase the productivity. In view of the lack of suitable and well adapted high yielding varieties to varied agro-ecological conditions, the present study was carried out to study the effects of different environments on yield and some yield attributes in black gram and also to find out high yielding stable varieties of black gram.

Materials and methods

Field experiments were conducted during *kharif* season, 2009 and 2010 at two locations creating six environments. Fourteen genotypes were used during the experiments. The source of these genotypes was AICRP - MULLaRP, CAU, Imphal, Manipur. The fourteen genotypes viz.,RBU1012, NDU3-4, Uttara, PantU-19, KU323, PantU-35, PantU-31, KU-99-22, KOBG-653, SB 27-3, Type 9, IPU02-1, NDU5-3 and NDU99-2(Ch).**S**ix environments were created in the present study. The details of the environments under which the experiments were conducted are given below:

Sl. No.	Environment	Treatment	Location	Initial Soil texture
1	E-1	Control (Without any treatment)	Research field of Genetics and Plant Breeding, (SASRD), Nagaland University, Medziphema.	Sandy Clay loam
2	E-2	Treatment with fertilizer only @20:40:20 NPK Kg/ha	Research field of Genetics and Plant Breeding, (SASRD), Nagaland University, Medziphema.	Sandy Clay loam
3	E-3	Treatment with FYM only @20 tons/ha	Research field of Genetics and Plant Breeding, (SASRD), Nagaland University, Medziphema.	Sandy Clay loam
4	E-4	Control (Without any treatment)	KVK Research farm of College of Horticulture and Forestry, Central Agricultural University, Pasighat.	Sandy loam
5	E-5	Treatment with fertilizer only @20:40:20 NPK Kg/ha	KVK Research farm of College of Horticulture and Forestry, Central Agricultural University, Pasighat.	Sandy loam
6	E-6	Treatment with FYM only @20 tons/ha	KVK Research farm of College of Horticulture and Forestry, Central Agricultural University, Pasighat.	Sandy loam

The experiment was laid out in a RBD with three replications in each environment. Each genotype was grown in a plot of 1.5 x 2 m^2 consisting of 5 rows of 2 m each with a spacing of 30 cm row to row and 10 cm plant to plant.

Ten competitive plants at random were taken from each plot in each replication under each environment to record the data on six characters. *viz.*,Days to 80% maturity of pods per plot, Plant height at maturity (cm), Clusters per plant, Number of pods per plant, 100 seed weight (gm.) and Seed yield per plant (gm.) Days to 80% maturity of pods per plot was recorded on plot basis by visual observation.

Statistical analysis of the data

The mean values for the different characters were used for statistical analysis, which was carried out using SPAR-2 Software.

Stability analysis

After testing homogeneity of the error variances by using Barlett's test (Gomez and Gomez, 1984) and having satisfied the homogeneity of variance for all the environments were performed. The data were analyzed according to the stability model as suggested by Eberhart and Russell (1966). According to this model, the regression of each variety on an environmental index and a function of the acquired deviations from this regression would provide an estimate of the desired stability parameters.

Results and discussion

Analysis of variance

The environment wise analysis of variance for different characters was presented in Table 2. It was evident from the environment wise analysis of variance that in E-1, only the character days to 80% maturity of pods was found to be significant whereas the remaining characters viz., plant height, number of clusters per plant, number of pods per plant, 100g seed weight (gm) and seed yield per plant were found to be non-significant. In E-2, plant height at maturity and 100g seed weight were found to be significant, while the remaining characters were found to be non-significant. In E-3, only plant height at maturity was found to be non-significant and the remaining characters were significant. In E-4, number of pods per plant and 100g seed weight were found to be non-significant while the remaining characters were found to be significant. In E-5, numbers of pods per plant and seed yield per plant were found to be non-significant while the remaining characters were found to be significant and in E-6, all the characters were found to be significant except 100 seed weight. The character wise pooled analysis of variance (Table 3),analysis of variance (mean squares Table 1) for phenotypic stability, environment (linear) component and variance ratio due to G x E (linear) were significant for all the characters. The mean sum of square due to pooled deviation was significant for 100 seed weight and the rest were found to be non-significant.

In the present study stability parameters such as mean (x), regression coefficient (bi) and deviation from regression (S^2di), as suggested by Eberhart and Russell (1966) were considered to explain and discuss the stability of different genotypes for the characters under consideration.

Based on Table 4, for days to 80% maturity of pods per plot, the genotypes PantU-31 and NDU3-4 required minimum number of days to maturity as compared to grand mean value with significant values of bi and significant S^2di value so they were considered to be unpredictable for stability. The genotypes PantU-19 had higher mean value greater than the general mean, bi greater than unity and non-significant S^2di so, was predictable for stability under favourable environments whereas, KU323, PantU-35 and NDU5-3 were predictable for stability only when the environment was made favourable. For the character, plant height at maturity (cm),out of fourteen genotypes Pant U-35, SB27-3 and Type 9 exhibited significant regression below unity revealing that plant height was closely associated with both favourable and unfavourable environmental conditions. The genotype Type-9 had the lowest mean plant height with regression value significantly lower than unity and non-significant S^2di value indicating its suitability for unfavourable environments, while Pant U-19 had the highest mean plant height with regression value significantly above unity and non-significant S^2di value indicating its suitability for favourable environments (Table 4). The most stable genotype for this character was found to be NDU3-4 having mean value greater than the general mean, bi equal to zero with non-significant S^2di value.

The genotypes COBG-653, PantU-19 and RBU1012 for the character number of cluster per planthad the mean values over the environments greater than the general mean, and their regression value greater than unity and S^2di value were found to be non-significant so, these genotypes were the most stable genotypes for favourable environment (Table 4). The genotype Pant U-35 could be regarded as better adapted genotype over specific environment. Similar results were also obtained by Revanappa *et al.* (2012) from his study on Genotype x Environment Interaction and Stability analysis for grain yield in black gram.

The character number of pods per plantwas found to be predictable for the genotypes Uttara, and KU-99-22 and NDU99-2 as the bi and S^2di were non-significantly deviated from unity and zero (Table 4.1). The genotypes RBU1012 and NDU5-3 had higher mean value and bi values greater than the general mean and unity respectively therefore, it could be predicted for favourable conditions while Uttara, KU-99-22, and NDU99-2 had lower mean values than the general mean with bi less than unity and S^2di non-significant therefore, these genotypes could be recommended for unfavourable environments. This result was further supported by Raffi *et al*. (2004).

The genotype RBU-1012 had non-significant bi and S^2di value with the mean value highest and greater than the general mean for the character 100 seed weight, this genotype could be considered as the most stable genotype followed by IPU02-1 for 100 seed weight (Table 5). The genotype Uttara and Pant U-35 had mean value lesser than the general mean, bi value greater than unity with non-significant S^2di; therefore these genotypes could be performed best in favourable environments. The genotypes SB27-3 had mean value less than the general mean, bi value less than unity with non-significant S^2di; so it could be performed best in unfavourable environments and IPU02-1 having mean value greater than general mean with non-significant bi and S^2di could be performed best in favourable environments (Table 5).

The character seed yield per plant (gm.)was found to be predictable for most of the genotypes except Type 9, SB 27-3 and KU-99-22 genotypes. The genotypes NDU5-3, COBG-653, RBU1012, PantU-19, PantU-35 and PantU-31 had mean values higher than the general mean with bi values greater than unity and S^2di values were found to be non-significant (Table 5). Therefore, these genotypes were stable for favourable environments. NDU3-4, Uttara, KU323, IPU02-1 and NDU99-2 had mean values less than the general mean with bi values lesser than unity and S^2di values were found to be non-significant. Therefore, they were stable for unfavourable environments. Similar results were also observed by Senthil KN. and Chinna GPS.K. (2012) also observed by Das R.T., Barua P K (2015) Senthil and Chinna (2012) and Das and Barua (2015) in green gram. In their experiment, twenty three genotypes of green gram were studied for genetic variability, correlation and path analysis for eight economically important traits.The genotypes viz. SG1, MH 709, ML 1278, Pant M 4, SG 21-5, OGG 56, CGG 973, ML 1354 and RVSM 11 were found promising for seed yield per plant. In general, PCV were higher than the corresponding GCV values for all the characters, suggesting the influence of environment in the expression of these traits.

For all the characters under studied, the value of C.D. (G) at 5%, no significant differences were found between the genotypes however significant differences were observed between the environments except for the characters 100 seed weight (gm.) and seed yield per plant (gm.) where,significant differences between the genotypes and environments were observed (Table 4 and 5).

On the basis of stability parameters, for days to 80% maturity Pant U-19 was the most stable genotype under favourable environment. Most stable genotype in case of plant height at maturity was Type-9. Pant U-35 was the most stable genotype under favourable environment for cluster per plant. RBU1012 and NDU5-3 were the most stable genotypes against all the environments for pods per plant, RBU1012 and KU323 were stable for 100 seed weight. For seed yield per plant RBU1012, Pant U-19 and Pant U-35 were found to be the most stable. Therefore, in view of the above estimated parameters of stability in the present study, genotypes RBU1012 and Pant U-19 was considered to be the most stable genotypes under the present created environments. Similar results were also obtained by Koli and Prakash (2012) working on stability of grain yield in complete randomized block design during kharif 2006–2010, at Agricultural Research station, Ummedganj Farm, Kota (Raj) under transplanted condition of South-Eastern plane Zone of Rajasthan.The genotypes yield, regression co efficient (bi), deviation from regression (S^2di) with sustainability index was used to identify the stability and adaptability of genotypes. Pooled analysis of variance showed highly significant differences among environments (year), genotypes and GXE interaction. Sufficient mean squares due to genotype x environment (G x E) interactions indicated that the genotypes interacted considerably with the environmental condition. Their result revealed that a large portion of G x E interaction was accounted for by the linear regression through pooled deviation was significant. Based on their estimated stability parameters and over all mean performance of grain yield, variety P-1121, P-2511 P-1460 and Pusa Basmati-1 were identified as superior, which were well adapted to all the environment, showing that these varieties were better responsive to the favorable environments.

Among the genotypes studied, earliest stable genotypes over the environments were KU-99-22 for days to 80% maturity of pods per plot. For plant height at maturity KU-99-22 was the most stable and shortest, while Pant U-19 recorded to be the tallest and most stable. Pant U-19 and COBG-653 for cluster per plant, RBU1012 and NDU5-3 for pods per plant under favourable environment and KU323, RBU1012 were stable genotypes for 100 seed weight. Pant U-35, Pant U-19, RBU1012 and Pant U-31 in descending order could be predicted for favourable environment in case of seed yield per plant. In view of yield and its components for which they were better performing under favourable environment, the genotype Pant U-35 for seed yield per plant, RBU1012 for pods per plant and KU323 for 100 seed weight. And could be considered as better performing genotypes over all the environments. The genotypes that performed best under unfavourable environment were KU-99-22 for pods per plant, SB27-3 for 100 seed weight and NDU-99-2 for seed yield per plant. Thus, these genotypes could be considered as better performing genotypes under unfavourable environment.The results were also supported by from their experiment on Evaluation of genotype by environment interaction (GEI) is very important for development of crop varieties with good potential. In their study, Eberhart - Russell' and AMMI approaches were used to analyse the pattern of stability under targeted environment. Their study revealed that environmental indices indicated that environment A and environment B were most favourable for most of the yield component traits, whereas environment C was unfavourable for almost all the yield and yield component traits. For seed yield; genotypes and environments were grouped into nine sectors (AMMI 2). The first sector consisted of with environment B with high IPCA score for some outlier genotypes *i.e.* G25, G14 and G22, indicated that the environment B was better than other environments and three genotypes were found stable for SYP.Also found that environment B (timely sown) was found ideal for seed yield followed by environment A (early sown) and C (late sown).

Table 1: Analysis of variance (mean squares) for different characters in black gram (Eberhart and Russell, 1966)

Source of variation	d.f.	Days to 80% maturity	Plant height	Cluster per plant	Pods per plant	100 seed weight	Seed yield per plant
Genotypes	13	92.24**	244.10**	22.27**	44.97**	0.16**	11.83**
Env. +(G x E)	70	223.83**	463.64**	25.46**	67.25**	0.19**	7.94**
Env. (linear)	1	14520.21**	26515.81**	1386.88**	2979.42**	7.50**	340.12**
G x E (linear)	13	40.73**	295.31**	10.76**	49.22**	0.11*	11.23**
Pooled deviation	56	11.04 NS	37.49 NS	4.56 NS	19.42 NS	0.08*	1.24 NS
RBU1012	4	2.95 NS	86.91*	3.66 NS	1.07 NS	0.07 NS	0.4 NS
NDU3-4	4	20.26 **	14.09 NS	8.48**	25.61*	0.11*	3.57*
Uttara	4	4.21 NS	11.35 NS	0.19 NS	17.39 NS	0.02 NS	1.08 NS
Pant U-19	4	5.08 NS	19.12 NS	2.54 NS	24.34*	0.10*	2.25 NS
KU323	4	10.89 NS	30.84 NS	5.27 NS	24.52*	0.03 NS	1.18 NS
Pant U-35	4	6.97 NS	96.05*	11.60**	49.95**	0.08 NS	1.83 NS
Pant U-31	4	34.48**	7.58 NS	8.72**	28.63*	0.19**	1.83 NS
KU-99-22	4	6.15 NS	22.64 NS	1.73 NS	11.95 NS	0.02 NS	0.11 NS
COBG-653	4	1.22 NS	33.92 NS	5.21 NS	33.96**	0.21**	1.54 NS
SB 27-3	4	2.79 NS	20.43 NS	4.19 NS	27.09*	0.04 NS	0.82 NS
Type 9	4	54.57**	76.75 NS	1.96 NS	3.63 NS	0.13**	0.33 NS
IPU02-1	4	2.78 NS	13.54 NS	1.07 NS	3.08 NS	0.03 NS	0.19 NS
NDU5-3	4	0.69 NS	64.81 NS	0.21 NS	1.26 NS	0.18**	0.20 NS
NDU 99-2	4	1.59 NS	26.94 NS	9.06**	19.52 NS	0.06 NS	1.80 NS
Pooled error	156	7.59	48.54	3.33	13.68	0.05	1.96

*, ** Significant at 5% and 1% level respectively NS= Not Significant

Conclusion

From the above findings, it could be concluded that the better genotypes for phenotypic stability of grain yield and its components were found to be RBU1012 and NDU5-3, both having higher mean yield could be considered for its stable performance, so it could be recommended for cultivation over wide environmental conditions. Among the environments, the E-6 (Pasighat, organic manure (FYM) treated) was found to be the best for yield and its components while the E-1(Medziphema, without any treated) was the lowest for yield and its components.

Future Research Strategies

A rigorous testing under varying environments/ locations is further needed:

1. To generate more information on this aspect before a genotype is recommended for its commercial cultivation.
2. After thorough multi-location testing, they may be used as commercialvariety as such or may be taken to breeding programme aiming towards developing suitable breeding materials with better stability.

Table 2: Analysis of variance (mean squares) for different characters in six different environments

Source of variation	d.f.	Days to 80% maturity	Plant height	Cluster per plant	Pods per plant	100 seed weight	Seed yield per plant
E-1 Replication	2	4.35**	119.66**	2.14 NS	2.00 NS	1.44**	0.45NS
Genotypes	13	16.56**	25.71 NS	1.44 NS	11.68 NS	0.31 NS	0.99NS
Error	26	1.99	28.40	1.82	7.78	0.18	0.54
E-2 Replication	2	36.85**	1302.55**	154.83**	360.82**	1.08**	49.74**
Genotypes	13	6.04 NS	134.34*	14.59 NS	51.05 NS	0.24*	4.25NS
Error	26	3.16	63.14	11.71	30.86	0.09	4.07
E-3 Replication	2	1.78 NS	1514.38**	37.60**	192.59**	0.04 NS	19.35**
Genotypes	13	22.38**	219.19 NS	17.38**	34.05*	0.14**	5.49*
Error	26	7.14	126.00	4.97	14.20	0.03	1.94
E-4 Replication	2	187.45**	125.37**	66.37**	132.59**	0.29 NS	146.17**
Genotypes	13	215.47**	94.32*	18.83**	22.83 NS	0.40 NS	34.53*
Error	26	63.68	39.52	5.05	15.67	0.36	12.19
E-5 Replication	2	238.73**	315.04*	125.52**	215.30**	0.47*	127.32**
Genotypes	13	190.90**	313.72*	39.41*	115.13 NS	0.70**	5.46NS
Error	26	19.19	126.84	17.06	69.83	0.18	4.42
E-6 Replication	2	37.16 NS	903.04 NS	612.46**	1239.63**	0.06 NS	146.17**
Genotypes	13	90.31**	1315.44**	66.41**	298.90*	0.16 NS	34.53*
Error	26	41.37	489.73	19.34	107.95	0.12	12.19

*, ** Significant at 5% and 1% level respectively NS= Not Significant

Table 3: Character wise pooled analysis of variance (mean squares) over all the environments for different characters in black gram

Source of variation	d.f.	Days to 80% maturity	Plant height	Cluster per plant	Pods per plant	100 seed weight	Seed yield per plant
Genotype (G)	13	92.24**	244.10**	22.27**	44.97**	0.16**	11.83**
Environment (Env.)	5	2904.04**	5303.16**	277.37**	595.88**	1.50**	68.02**
G x Env.	65	17.66**	91.36*	6.08*	26.58*	0.09**	3.32**
Pooled error	156	7.59	48.54	3.33	13.68	0.05	1.96

*, ** Significant at 5% and 1% level respectively NS= Not Significant

Table 4: Genotypic means with stability parameters for some important component characters

Sl. No.	Genotype(G)	Stability parameters								
		Days to 80% maturity			Plant height (cm)			Clusters per plant		
		$\overline{Xi}$	bi	S^2di	$\overline{Xi}$	bi	S^2di	$\overline{Xi}$	bi	S^2di
1.	RBU1012	81.28	0.76**++	-6.1	49.27	0.82*	24.86*	10.76	1.26**	-3.39
2.	NDU3-4(AVT2)	78.78	0.87**	11.2**	41.70	1**	-47.96	8.71	0.65	1.42**
3.	Uttara	79.89	1.02**	-4.84	41.56	1.37**	-50.7	8.43	0.98**	-6.87
4.	PantU-19	82.44	1.1**	-3.96	48.51	1.2**	-42.94	12.01	1.71**	-4.51
5.	KU323	79.33	0.96**	1.84	39.29	1.13**	-31.21	7.74	0.81*	-1.79
6.	PantU-35	79.89	0.86**	-2.08	40.52	0.72**	33.99*	13.81	1.41*	4.54**
7.	PantU-31	75.72	0.89**	25.42**	30.56	0.64**++	-54.47	8.48	1.11*	1.67**
8.	KU-99-22	79.33	0.95**	-2.9	34.88	0.78**	-39.41	7.42	0.63**+	-5.33
9.	KOBG-653	82.00	0.85**++	-7.83	42.92	1.06**	-28.14	10.99	1.29**	-1.85
10.	SB 27-3	80.44	1.05**	-6.25	35.51	0.65**+	-41.62	8.23	0.85*	-2.87
11.	Type 9	93.39	1.6**	45.51**	27.82	0.25+	14.69	7.88	0.71**	-5.1
12.	IPU02-1	80.44	1.04**	-6.27	39.16	1.15**	-48.52	7.58	0.9**	-5.99
13.	NDU5-3	80.22	0.98**	-8.35	48.34	1.83**	2.76	8.88	1.07**	-6.84
14.	NDU99-(Ch)	79.89	1.05**	-7.46	41.37	1.38**	-35.11	8.00	0.61	1.99**
Mean		80.93			40.10			9.21		
C.D. (G) at 5%		3.13			7.93			2.08		
C.D. (E) at 5%		2.05			5.18			1.36		

*, ** bi and S^2di values significantly deviated from 0 at 5% and 1% levels respectively.

+, ++ bi values significantly deviated from unity at 5% and 1% levels respectively

cont...

Table 5: Genotypic means with stability parameters for some important component characters

Sl. No	Genotype(G)	Stability parameters								
		Pods per plant			100 seed weight			Seed yield per plant		
		$\overline{Xi}$	Bi	S^2di	$\overline{Xi}$	bi	S^2di	$\overline{Xi}$	bi	S^2di
1.	RBU1012	19.99	1.52**	-20.14	4.87	0.73	0.003	6.79	1.51**	-3.36
2.	NDU3-4(AVT2)	15.36	0.72	4.4*	4.69	0.86	0.04*	5.49	0.80	-0.19*
3.	Uttara	15.10	0.74	-3.82	4.35	1.71**	-0.05	4.55	0.48	-2.43
4.	PantU-19	20.70	1.78**	3.13*	4.42	0.99	0.04*	7.39	1.84**	-1.52
5.	KU323	13.38	0.66	3.31*	4.67	0.99*	-0.03	5.07	0.92*	-2.59
6.	PantU-35	21.52	1.87*	28.73**	4.48	1.73*	0.02	8.55	2.47**	-1.94
7.	PantU-31	17.98	1.23*	7.42*	4.60	1.69*	0.12**	6.10	1.42**	-1.93
8.	KU-99-22	13.07	0.44	-9.26	4.54	0.6*	-0.04	3.57	0.23*++	-3.65
9.	KOBG-653	18.81	1.33*	12.74**	4.51	0.49	0.14**	5.97	1.32**	-2.22
10.	SB 27-3	15.93	0.71	5.88*	4.21	0.4	-0.03	4.33	0.22+	-2.94
11.	Type 9	15.51	0.62**+	-17.58	4.45	1.14	0.06**	4.66	0.44*++	-3.34
12.	IPU02-1	14.52	0.71**	-18.13	4.54	0.57	-0.03	4.85	0.75**	-3.58
13.	NDU5-3	17.50	1.2**	-19.95	4.67	0.78	0.11**	6.09	1.35**	-3.56

14.	NDU99-(Ch)	14.40	0.46	-1.69	4.39	1.29*	-0.005	3.79	0.24	-1.97
Mean		16.70			4.53			5.51		
C.D. (G) at 5%		4.21			0.25			1.60		
C.D. (E) at 5%		2.75			0.16			1.04		

*, ** bi and S^2di values significantly deviated from 0 at 5% and 1% levels respectively.

+, ++ bi values significantly deviated from unity at 5% and 1% levels respectively

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